A WIDESPREAD PLIOCENE MOLLUSCAN FAUNA WITH ANODONTIA IN SOUTH AUSTRALIA.

by N. H. Ludbrook*

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SUMMARY

A shallow water molluscan fauna with large pelecypods including *Anodontia sphericula* (Basedow) is described from transgressive Pliocene sediments occurring from Fishery Bay on Eyre Peninsula to Moorlands in the Murray Basin.

INTRODUCTION

At widely separated localities in South Australia, thin, apparently synchronous Pliocene limestones and sandstones carry a fauna characterized by an abundance of large pelecypods. The most conspicuous and interesting is a large globular shell the size of a flattened tennis ball, casts of which readily weather out from the limestones. These globular casts have been variously known as *Dosinia greyi* Zittel and *Meretrix sphericula* Basedow, but the adductor impressions and the pallial line are those of the *Lucinidae*. The only complete specimen so far recovered consists of a pair of valves recorded by Howchin (1936, p. 7) from the Cowandilla Bore at 470-485 feet. From this specimen it has been possible to identify the genus *Anodontia* to which Basedow's species should be referred.

DISTRIBUTION OF THE FAUNA

The molluscan assemblage has been identified from as far west as Fishery Bay on southern Eyre Peninsula to Moorlands in the Murray Basin. Many of the outcrops represent strand lines of the transgressive shallow seas distinguishing this part of the Pliocene. Deposition took place in shallow bays, the abundance of *Pectinidae* indicating sandy bottoms and of *Ostreidae* the existence locally of restricted conditions favourable to the development of thick oyster beds. Not all oyster beds occurring in the Murray Basin were contemporaneous with the present fauna. There has been a tendency to regard those of the western margin of the Basin as belonging to a single unit, but this is not so. The stratigraphic levels at which oyster beds occur still awaits the result of detailed mapping and examination of the vertical ranges and associated faunas of the three species which occur in the Loxton Sands and Norwest Bend Formation – *Ostrea hyotidoidea*, *O. sturtiana*, and *O. arenicola*.

Most of the Pliocene outcrops are very thin, seldom exceeding five feet in thickness. They were deposited in markedly transgressive seas. At both Fishery Bay and Moorlands the conglomeratic limestones overlap bedrock, of which pebbles up to small boulder size are caught up in the limestone. The probable margins of the sea at this time are indicated in Fig. 1; areas known to have been inundated are shaded.

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On *Eyre Peninsula* at *Fishery Bay*, at the south end of Sleaford Bay, 20 miles south-west of Port Lincoln, basement granite pebbles occur in limestone with molluscan moulds and casts of *Anodontia sphericula, Vasticardium submaculosum, Fulvia tenuicostata, Miltha hora, Antigona cognata, Cassis (Hypocassis) salisburyensis,* all of which have been identified from casts weathered from the matrix. This assemblage is represented in the molluscan fauna of the Dry Creek Sands. The material from Fishery Bay was collected by R. K. Johns.

The occurrence in Deep Creek, Hundred of Poynton, 20 miles south-south-west of Whyalla, has been described elsewhere (Miles, 1954, p. 25).

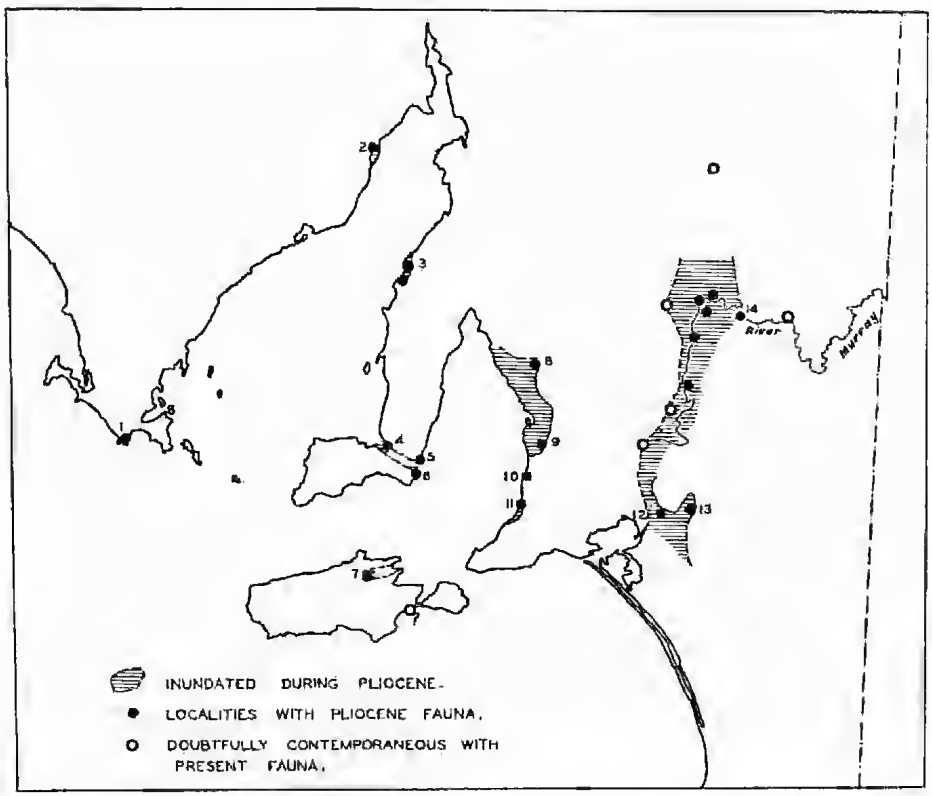

Fig. 1.—1. Fishery Bay; 2. Hd. Poynton; 3. Wallaroo; 4. Hd. Moorowie; 5. Giles Point; 6. Edithburg; 7. Hd. Menzies; 8. Redbanks; 9. Adelaide; 10. Hallett Cove; 11. Aldinga Bay; 12. Tailem Bend; 13. Moorlands; 14. Waikerie.

On *Yorke Peninsula*, Pliocene sandy limestones outcropping on the coast at Edithburg and entered in wells west of Edithburg, were described by Basedow (1901) and correlated with other Pliocene occurrences then regarded as of Miocene age. From the Edithburg material Dr. Basedow described four molluscan species including *Meretrix sphericula* and *Campanile triseriale*. Basedow's types and also the type material of *Tellina basedowi*, which according to Basedow (1901, p. 148) was deposited in the Museum of the University of Adelaide, have disappeared.

Recently, Mr. E. J. Carmichael, of Yorketown, has collected assiduously from the Pliocene on his property on Section 140, Hundred of Moorowie, where the limestone is burned for lime and underground water is obtained at shallow

depth at the base of the formation where it rests on Permian till. Mr. Carmichael's interest has greatly helped in replacing some of the Basedow types and in identifying the extent of the Pliocene in southern Yorke Peninsula.

At Edithburg itself 3 feet of Pliocene sandy limestone covered by 15 feet of kunkar is exposed at Point de Mole at the foot of the steps leading to the old bathing pool. Limestone blocks with abundant *Chlamys antiaustralis* and *Spondylus spondyloides* are strewn at high tide level. From this locality the neotype of *Cardita denmanti* was collected by Mr. Carmichael.

Two miles north of Coobowie at Giles Point, Section 319, Hundred of Melville, a three-foot oyster bed in sandstone is exposed above high tide level at the base of low cliffs 27 feet high. *Tellina basedowi* was re-collected from this exposure. Associated molluscan species are *Ostrea arenicola* and *Chlamys* (*Chlamys*) *antiaustralis*; the foraminifera include *Cribrobulimina polystoma, Triloculina trigonula, Discorbis dimidiatus, Elphidium adelaidense, E. rotatum, "Rotalia" beccarii,* and *Marginopora vertebralis.* The oyster bed is overlain by 22 feet of mottled clayey sandstone with a gravel bed at the base. This is usually considered though not proven to be of Pleistocene age.

From the wall 20 feet below the surface of a well on Section 200, Hundred of Melville, 1½ miles west of Edithburg, A. A. Gibson recently collected a sample of sandy limestone with *Chlamys antiaustralis* and *Chlamys* (*Equichlamys*) *palmipes.* This appears to be the well described by Basedow (1901, pp. 146-7).

No Pliocene has been observed north of Giles Point on the eastern side of Yorke Peninsula although some marginal limestones near Kulpara and Clinton lithologically resemble the characteristically sandy limestones of the Pliocene. The limestones at Kulpara and Clinton, however, carry *Austrotrillina howchini* and locally *Lovenia* and *Monostychia*; they are of Lower Miocene age.

On the western side of the Peninsula two exposures are known near Wallaroo, one at Point Hughes 1 mile west-south-west and a second 2 miles north of the town on Section 925, Hundred of Wallaroo, where Pliocene limestone with abundant molluscan moulds and casts was formerly quarried for flux for the smelters. The fauna, identified from latex casts, includes abundant rather small moulds of *Anodontia sphericula* and *Diastoma provisi,* with *Cucullaea.*

An interesting exposure of the Pliocene occurs on *Kangaroo Island.* Limestone boulders collected by E. P. O'Driscoll on Section 268, Hundred of Menzies, 11 miles west of Kingscote, carry abundant *Chlamys antiaustralis* in association with *Ostrea,* mostly juveniles, ? *Cardita* sp., *Barbatia* sp., *Cucullaea* sp., *Chlamys* (*Equichlamys*) *consobrina* and *Diastoma provisi.* Although no basalt was actually seen by Mr. O'Driscoll during his short visit to the locality, the limestone has been baked by the basalt which occurs to the west of Kingscote. The fauna is consequently poorly preserved, mainly as casts, moulds, and hardened shells in reddish and grey limestone.

Along the *eastern coast of Gulf St. Vincent* the Pliocene occurs discontinuously from Aldinga Bay to Adelaide, and the exposures at Aldinga, Hallett Cove and Adelaide have been described by many authors. The sequence in the Dry Creek Sands of the Adelaide Plains Basin is, however, understood only in general terms at present; only one of the molluscan faunas has been described (Ludbrook, 1954-8) and no zoning of the foraminifera has been undertaken.

An exposure of Tertiary beds at *Redbanks* on the River Light was described by Howchin (1912) and correlated with rocks of Older Tertiary ("Eocene") age elsewhere in South Australia. Some anachronous features of the molluscan species collected from this locality led to the recognition (Ludbrook, 1957, p. 17) of a very thin remnant of Pliocene calcareous sandstone overlying Miocene limestone (Howchin's Eocene).

The general features of the occurrence have been adequately described by Howchin. The Tertiary beds consist of from 12 to 15 feet of hard fossiliferous yellow limestone (calcarenite), gritty near the base, carrying the echinoids *Lovenia "forbesi* T. Woods", *Fibularia gregata*, and the pelecypods *Lentipecten* sp. and *Eotrigonia semiundulata*. The associated microfauna contains *Amphistegina lessonii, Calcarina verriculata, Notorotalia howchini* and species of *Gaudryina, Dorothia, Nonion, Cibicides*, and *Cassidulina*. An echinoid band occurs near the top of the limestone, with abundant *Lovenia, Monostychia, Fibularia* and *Lentipecten*, together with *Eotrigonia semiundulata* and *Placotrochus*. Erosion has considerably obscured the contact between the top of the echinoid band and the overlying thin remnant of leached white calcareous sandstone with chalky remains of *Glycymeris convexa*. Where it is best exposed under Pleistocene mottled clays, the sandstone rests upon poorly fossiliferous Miocene calcarenite with echinoid spines, sponge spicules, and miliolid foraminifera; elsewhere it may be represented by a coarse grit resting on the echinoid band of the limestone. Howchin (p. 17) noted the rich fossil content of this "thin siliceous layer". It is obvious from the megafossil assemblage that this is not a bed of the underlying Miocene, but a remnant of the Pliocene Dry Creek Sands encountered in borings in the Adelaide Plains Basin.

One small, loose boulder from the echinoid band of the Miocene carries, vertical to the bedding, a mould of the boring mollusc *Pholas* on the infilling of a tube bored into the limestone. An irregular junction between limestone and grit is also visible on the same boulder.

The Redbanks exposure probably represents the north-eastern margin of the Pliocene sea in this part of the St. Vincent Basin. Although the total exposure is only about 8 feet long and 1 foot thick, the following molluscan species, some of which are restricted to the Pliocene, have been identified: *Nuculana verconis, Glycymeris convexa, Cucullaea* sp., *Chlamys antiaustralis, Carlita compta, Miltha hora, Notocallista* (*Striacallista*) sp., *Dentalium latesulcatum, Turritella acricula adelaidensis, Diastoma provisi, Thericium torri, Polinices substolida, Conus* (*Floraconus*) *adelaidae*. *"Rotalia" beccarii* is associated with this assemblage.

Overlying the Tertiary marine beds are about 40 feet of Pleistocene mottled, mainly red, clays and loam.

At *Tailem Bend* the low cliffs forming the eastern bank of the Murray River are composed of fine calcareous loosely coherent sandstone with abundant *Marginopora vertebralis* visible on weathered surfaces. In this area the Miocene has been partially or wholly removed by erosion and Pliocene sands rest directly on grey limestone of the Ettrick Formation. 2½ miles south of Tailem Bend on the stock route adjacent to Section 321, Hundred of Seymour, well preserved mollusca occur in a bed of *Ostrea arenicola* 25 feet down the low cliffs. The splendid specimen of *Spondylus spondyloides* (Pl. 2, Fig. 1) was collected at this locality with *Chlamys* (*C.*) *antiaustralis, Chlamys* (*Equichlamys*) *palmipes*, and *Miltha hora*.

The associated microfauna is similar to that of the Dry Creek Sands.

The sample taken on the eastern bank at Jervois punt contains a shallow water formaminiferal assemblage with *Marginopora vertebralis* and *"Rotalia" beccarii* in abundance, in association with *Trochammina inflata, Clavulina multimurerata, Cribrobulimina polystoma, Quinqueloculina costata, Triloculina trigonula, T. tricarinata, Peneroplis pertusus, Discorbis dimidiatus, Rotorbinella cycloclypeus*. The foraminifera of the oyster bed with *Spondylus*, 2½ miles south of Tailem Bend, include *"Rotalia" beccarii* with *Quinqueloculina costata, Q. polygona, Triloculina tricarinata, Guttulina irregularis, G. problema, G. regina, Sigmoidella elegantissima, S. kagaensis, Discorbis dimidiatus, Rotorbinella cyclo-*

clypeus, Planulinoides biconcava, Planorbulina mediterranensis, Elphidium adelaidense, E. rotatum, E. macellum, E. advenum.

The Pliocene at *Moorlands* has been described by McGarry (1953, p. 87). Five species of mollusca occurring in this locality were recorded by Mawson and Chapman (1922, p. 136). Thin, highly fossiliferous sandy and gritty limestone with large slate pebbles overlies bedrock on Section 6, Hundred of Sherlock, on the roadway where it is thinly covered with kunkar, and to the south of the roadway. *Anodontia sphericula* is abundant, in association with *Macoma basedowi, Chlamys (Equichlamys) consobrina, Diastoma provisi, Barnea tiara, Anapella variabilis,* and doubtfully identified *Antigona cognata.*

The distribution of the fauna at these localities is tabulated below.

The sandy limestone quarried at *Waikerie* as a building freestone also contains *Anodontia sphericula* and *Diastoma provisi* with moulds of *Polinices* and *Mytilus.*

DISTRIBUTION TABLE

	Moorlands	Tailem Bend	Aldinga Bay	Hallett Cove	Adelaide Plains Basin	Kangaroo Island	Edithburgh	Wallaroo	Eyre Peninsula
Cucullaea sp.			x	x	x	x		x	x
Glycymeris convexa	x	x			x				
Ostrea arenicola		x	0	x	x	cf	x		
Chlamys antiaustralis	x		0	x	x	x	x		x
Chlamys (Equichlamys) consobrina	x		0	x	x	cf			
Chlamys (Equichlamys) palmipes	x		0	x	x	cf			
Chlamys (Equichlamys) subbifrons			x		0				
Spondylus spondyloides		x	0	x	x				
Glans dennanti							0		
Anodontia sphericula	x		x	x	x		0	x	x
Antigona cognata	x								
Dosinia (Phacosoma) edithburgensis							0		
Luciolina aldingae			0						
Macoma basedowi	x						0		
Anapella variabilis	x		0		x				
Diastoma provisi	x		x	x	0	x		x	x
Campanile triseriale			x	x	x		0		

0 Type locality
x Occurrence noted.

SYSTEMATIC DESCRIPTIONS

Family PECTINIDAE

Genus CHLAMYS Röding, 1798

Subgenus CHLAMYS s. str.

Chlamys (Chlamys) antiaustralis (Tate)

Synonymy: Ludbrook, 1955, p. 30.

Observations—The species was well figured by Gatliff and Singleton (1930, pl. 2, fig. 3; pl. 3, figs. 6, 7; pl. 4, fig. 10). It occurs commonly in calcareous sandstones carrying the present fauna.

Subgenus EQUICHLAMYS Iredale, 1929

Type species (o.d.) *Pecten bifrons* Lamarck

Group of *Chlamys* (*Equichlamys*) *bifrons* (Lamarck)

Three species described by Tate, *Pecten consobrinus*, *P. subbifrons* and *P. palmipes*, are each morphologically close to variants of the living *Chlamys* (*Equichlamys*) *bifrons*, the type of which is in the Lamarck Collection in the Museum of Natural History, Geneva. These either represent allopatric populations of a single Pliocene species or are Pliocene subspecies of a single polytypic species of which *bifrons* is the living South Australian representative. The amount of material available is, however, too limited for satisfactory comparative study.

Chlamys (Equichlamys) subbifrons (Tate)

pl. 1, fig. 1

Pecten subbifrons Tate, 1882, p. 44; 1886, p. 104, pl. 3, fig. 2.

Diagnosis—A rather small *Equichlamys* with 12 square-cut bifid ribs equal to the interspaces, cut into riblets in the early stages by a median groove and into 4 or 5 riblets by dichotomous grooves towards the ventral margin. Main interspaces and rib grooves shagreened.

Description—The holotype figured by Tate is a juvenile right valve, narrower than the adult. Shell of small to medium size, weakly inflated, height (in the juvenile) greater than the length, anterior-dorsal and posterior-dorsal margin slightly concave, ears large, unequal, posterior ear triangular, with 5 rays with shagreen interspaces; anterior ear larger, upper margin directed slightly upwards, lower margin with a broad but not very deep byssal notch, 6 rays, the upper bifid and much broader than the rest which are divided by one or two grooves, interspaces shagreen.

Main shell sculpture of 12 square-cut ribs, equal to the interspaces. Ribs cut into riblets by one increasing to three square-cut grooves towards the ventral margin. Riblets more or less granular, about 13 granules in 10 mm. Grooves shagreen. Interspaces between main ribs shagreen with a secondary riblet developing by intercalation. Valve margin squarely undulating.

Dimensions—Height 30, length 28 mm.

Type Locality—Pliocene, "Government House Quarry", Adelaide.

Location of Holotype—Tate Museum Collection, University of Adelaide, T 959A.

Material—The holotype and 4 paratypes, Adelaide.

Observations—The holotype is an ornamented phase of the species. The granules are not always present on the ribs which in juvenile paratype D are shagreened over.

Chlamys (Equichlamys) consobrina (Tate)

pl. 1, fig. 2

Synonymy: Ludbrook, 1955, p. 31.

Diagnosis—A fairly large *Equichlamys* with about 8 low radial folds. Folds and interspaces covered with narrow radial riblets increasing by intercalation to about 100 in the adult. Interspaces shagreen.

Description—Holotype left valve. Shell not fully grown, of medium size, moderately inflated, height equal to length, equilateral, anterior-dorsal and posterior-dorsal margins concave, ears large, unequal, anterior ear triangular, with

10 narrow radial riblets separated by broader shagreened interspaces, posterior ear subtriangular, carrying narrow radial riblets, outer margin broken but apparently very gently sigmoidal, upper margin straight.

Shell with 8 low folds strongest at the middle and almost obsolete anteriorly and posteriorly, both folds and interspaces carrying 3 or 4 flat, slightly granular ribs with shagreened interspaces a little wider than the ribs. Valve margin very gently undulating.

Dimensions—Height 67, length 67 mm.

Type Locality—Pliocene, Aldinga Bay.

Location of Holotype—Tate Museum Collection, University of Adelaide, T 937B.

Material—The holotype, one paratype (adult 85 × 85 mm.), 5 topotype fragments; one poorly preserved specimen in limestone, Moorlands.

Chlamys (Equichlamys) palmipes (Tate)

pl. 1, figs. 3-6

Pecten palmipes Tate, 1886, p. 105, pl. 5, fig. 4; pl. 7, figs. 4a-4b.

Diagnosis—A fairly large *Equichlamys* with 9 strong broad ribs on the right valve and 8 narrow elevated ribs on the left valve, ribs and interspaces covered with flat, square-cut riblets up to 15 on each rib on the right valve. Interspaces shagreened. Height greater than length. Dorsal margins conspicuously concave.

Description—Lectotype. Shell fairly large, roundly triangular, inequilateral, slightly inequivalve, higher than long, anterior-dorsal margin shorter than posterior-dorsal, but both relatively short, concave, ventral margin strongly convex. Ears large, unequal.

Right valve with 9 strong broad subrectangular ribs with U-shaped interspaces. The ribs in the median part of the shell are straight and radial, but both anteriorly and posteriorly they become increasingly concave. The two bordering the dorsal margins are separated from the adjacent ribs by a narrow interspace, which varies in intensity in individual specimens. It seems, therefore, a matter of individual preference as to whether the valve is regarded as having 7 (Tate, 1886) or 9 ribs. Ribs broadening and flattening ventrally. Interspaces shagreened. Ears unequal. Posterior ear triangular, outer margin slightly inclined to the vertical, with 11 radiating riblets grooved towards the umbo. Anterior larger, upper margin directed slightly upwards, outer margin convex, lower margin with a broad shallow byssal notch.

Left valve rather flattened in the umbonal region, anterior dorsal margin shorter than posterior, concave; posterior-dorsal margin concave; ventral margin roundly convex, profile narrowly undulating. Valve with 8 narrow inverted U-shaped ribs with deep interspaces twice as wide as ribs which widen and flatten ventrally. Ribs and interspaces carrying riblets developing by intercalation from about 3 per rib in the middle of the shell to about 7 at the ventral margin. Interspaces between ribs and riblets shagreened. Ears unequal. Anterior larger than posterior, triangular with 5 primary and radiating riblets with a secondary riblet developing in each interspace; posterior subtriangular, upper margin sloping downwards, outer margin meeting it at 115°.

Dimensions—Height 75, length 72, inflation (both valves) 27 mm.

Type Locality—Pliocene, Edithburg.

Location of Lectotype—Tate Museum Collection, University of Adelaide, T 932A.

Material—The lectotype and paratype T 932B, both complete specimens except for damage to posterior-ventral margin of holotype. One complete juvenile with smooth ribs and 4 valves, Tailem Bend; 1 valve in limestone with *Chlamys antiaustralis*, well at 20 feet, Section 200, Hundred of Melville, 1½ miles west of Edithburg.

Observations—Tate's description was based on two specimens, both of which were figured. The larger T 932A (figured 1886, pl. 7, figs. 4a-4b), of which Tate gave the approximate dimensions, is chosen as lectotype.

Family SPONDYLIDAE

Genus SPONDYLUS Linné, 1758

Spondylus spondyloides (Tate)

pl. 2, fif. 1

Synonymy: Ludbrook, 1955, p. 34.

The magnificent specimen (pl. 2, fig. 1) Tate Mus. Coll. F 15470, with both valves intact was collected south of Tailem Bend in calcareous partially coherent sandstone.

Family CARDITIDAE

Genus GLANS Megerle, 1811

Type species (monotypy) *Glans trapezia* = *Venus trapezia* Linné

Glans dennanti (Tate and Basedow)

pl. 2, figs. 2, 3

Cardita dennanti Tate and Basedow, 1902, p. 132, pl. 2, fig. 4.

Diagnosis—A subtrapezoidal inflated *Glans* with about 20 rather broad nodulose ribs.

Description—Neotype. A single right valve of moderate size, broadly subtrapezoidal in outline, strongly inflated, solid. Umbo prominent, inflated, strongly prosogyrous, situated at one-third from the anterior margin. Lunule small, cordate, escutcheon well defined. Anterior-dorsal margin almost straight, anterior margin arcuate, posterior-dorsal margin gently convex, posterior margin obscured by matrix, ventral margin gently convex. Sculpture of about 20 broad nodulose ribs wider than the interspaces. Ribs and interspaces crossed by irregular growth lines. Inner valve margin coarsely crenulate. Hinge fairly broad, damaged, but showing a strong, high, prominent, triangular 3b.

Dimensions—Height 23, length 24, inflation (one valve), 10 mm.

Location of Neotype—S.A. Museum No. P 12657.

Type Locality—De Mole Point, Edithburg.

Material—The neotype only. Although the dimensions are greater, the specimen collected by Mr. E. J. Carmichael from Point de Mole is so like the figure of the holotype that there can be no hesitation in selecting it as the neotype.

Family LUCINIDAE

Genus ANODONTIA Link, 1807

Anodontia Link, 1807, p. 156.

(*Loripinus* Monterosato, 1883, p. 91).

(*Eophysema* Stewart, 1930, pp. 37, 186; *non Anodontia* Stewart, 1930, p. 179.

Anodontia Link, 1807, Eames, 1951a.

Type species (monotypy) *Anodontia alba* Link = *"Venus" edentula* Linné

Anodontia sphericula (Basedow)

pl. 3, figs. 1, 2, 3; pl. 5, figs. 1, 4

Meretrix sphericula Basedow, 1902, p. 131, pl. 2, fig. 2; Howchin, 1935, pp. 84, 89; 1936, pp. 7, 14.

Diagnosis—A large globose *Anodontia*, thin shelled, sculptured with irregular growth lines about 1 mm. apart, with very fine secondary threads between. Hinge edentulous, anterior adductor well within pallial line, rectangular, about 20 mm. × 6 mm., posterior adductor subtriangular, about 10 × 10 × 15 mm.

Description—Shell large, thin, transversely orbicular, strongly inflated, sculptured with fine distinct accremental ridges about 1 mm. apart in the middle of the shell with fine secondary irregular microscopic threads between them and very fine short microscopic radial striae discernible on some portions of the adult shell.

Anterior area narrow, marked externally by a slight interruption of the concentric ridges which fold over on a slight umbo-ventral furrow. Posterior area narrow, less conspicuous than anterior area but similarly separated from the main part of the shell by a slight depression from the umbo to the posterior ventral edge.

Umbo small, smooth, sharp, not prominent, prosogyrous, situated anteriorly in the ratio 26:37. Anterior-dorsal margin almost straight, directed slightly upwards, meeting the anterior end in a broad curve. Posterior-dorsal margin relatively long and gently convex; gently descendent towards the posterior, meeting the posterior margin at a rounded obtuse angle. Ventral margin strongly convex.

Hinge edentulous, ligament long, narrow, bounded by a ridge. Anterior adductor long, rectangular, within the pallial line and diverging from it at an angle of about 20 degrees over three-quarters of its length, 21 mm. long, 6 mm. wide in the Cowandilla hypotype. Posterior adductor subtriangular, pointed dorsally with straight sides each 10 mm. long, ventral side convex towards the ventral margin, about 15 mm. long. There is a conspicuous umbo-ventral ridge bordering the inner side of the posterior adductor and a less conspicuous furrow extending from the inner margin of the anterior adductor in a broad sigmoid curve towards the posterior end of the hinge at the top of the pedal retractor. Pallial line simple, area outside pallial line smooth, inside granular.

Dimensions—Neotype height 72, length 82, inflation (cast, both valves, 47). Hypotype, Cowandilla Bore, height 57, length 63, inflation (both valves) 31 mm.

Type Locality—Edithburg.

Location of Types—South Australian Museum, Neotype P 12658; Hypotype, Moorowie, P 12659; Hypotype, Cowandilla Bore, 470-485 feet, Tate Mus. Coll., University of Adelaide, F 15471.

Material—The neotype and 2 topotypes collected from Edithburg in the Howchin Collection, S.A. Museum. 1 specimen 305 from Giles Point in collection of E. J. Carmichael, 9 specimens, Hundred Moorowie, Section 140, E. J. Carmichael Collection. 4 casts Wallaroo, 2 casts Aldinga, 2 casts Moorlands, 3 casts Fishery Bay; 17 fragments Cowandilla Bore, 1 valve Bore, Hundred of Munno Para, Section 4251, S.A. Mines Department Collection, Hypotype F 15471 placed in Tate Collection.

Observations—The whereabouts of the holotype are not known, but there has been no difficulty in finding specimens to replace it. The hypotype from Hundred of Moorowie is a large example, partly decorticated but with a fair amount of the outer shell layer still remaining. 22 adult specimens were mea-

sured, the average dimensions of which were height 64 mm., length 71 mm., inflation 43 mm., umbo-anterior 29 mm., umbo-posterior 42 mm., ratio height: length 0·901, ratio umbo-posterior:umbo-anterior 1·44. In the adult the height: length ratio varies from 0·90 to 0·95, in the juvenile from 0·80 to 0·95; in the adult the position of the umbo is more central in the ratio UP:UA is 1·23:1·62; in the juvenile the ratio UP:UA is 1·00:1·61.

Large globular casts of this species are very common in the limestones. With the removal of the shells by solution, the casts readily weather out. Casts appear to be similar to those of *Anodontia pharaonis* (Bellardi) occurring in the Eocene from Spain to India (Cox, 1936, p. 32; Eames, 1951b, pp. 390-2). *A. philippiana* (Reeve) from North Queensland is a close living relative. The species, or one very close to it, also occurs in the Pleistocene sandy limestones of the Eyre (Roe) Plain south of the Hampton Scarp in the Eucla Basin.

Family DOSINIIDAE

Genus DOSINIA Scopoli, 1777

Type species (monotypy) *Chama dosin* Adanson = *Venus concentrica* Born

Subgenus PHACOSOMA Jukes-Brown, 1912

Type species (o.d.) *Artemis japonica* Reeve

Dosinia (Phacosoma) edithburgensis sp. nov.

pl. 3, fig. 4

Dosinia grayii Zittel, Basedow, 1901, p. 147 (non Zittel).

Diagnosis—A fairly large suborbicular *Phacosoma*, moderately thin-shelled, sculptured with fine, erect ridges about 2 mm. apart, with about 8 fine striae on the interspaces and ridges. Pallial sinus deep, triangular, with apex about the middle of the median umbo-ventral line.

Description (*Holotype*)—Shell large, suborbicular, umbos inflated, prominent strongly prosogyrous, lunule deeply impressed, somewhat sagittate. Escutcheon narrow, deep. Sculpture on adult portion of shell consists of narrow concentric ridges about 2 mm. apart with finely striated interspaces.

Hinge plate moderately narrow, partly obscured by matrix. Hinge of right valve with long, narrow, high grooved posterior cardinal, a prominent bevelled median cardinal and a narrowly triangular entire anterior cardinal. Anterior lateral portion of hinge obscured. Pallial sinus not visible in holotype.

Dimensions of Holotype—Height 66, length 65, inflation (both valves) approximately 34 mm.

Paratype—Internal cast with a good deal of the original shell. Part of the pallial sinus visible, broadly triangular, deep, inclined, with apex directed towards the anterior end of the hinge at the probable position of the anterior adductor; apex at about the middle of the median umbo-ventral line.

Type Locality—Edithburg, Pliocene.

Location of Types—Tate Museum Collection, University of Adelaide, Holotype F 15467, Paratype F 15468.

Observations—This is one of the shells recorded by Tate as *Dosinia grayii* Zittel. It is a larger shell with only a superficial resemblance to *D.* (*Kereia*) *greyi* Zittel from New Zealand and has not so far been collected from any other locality than Edithburg. Two specimens in the Tate Collection from "Miocene, Gippsland Lakes"—probably Jemmy's Point Formation (Pliocene)—appear to be long to Kereia, although the hinge is obscured. They are somewhat similar

to but not conspecific with *greyi*. Marwick (1926, p. 570) has noted that the Japanese subgenus *Phacosoma* is not known to occur in New Zealand before the Lower Pliocene.

Family TELLINIDAE

Genus MACOMA Leach, 1819

Type species (monotypy) *Macoma tenera Leach* = *Tellina calcarea* Linné

Macoma basedowi (Tate)

pl. 4, figs. 3, 4

Tellina basedowi Tate in Basedow, 1901, p. 148, pl. 3.

Diagnosis—A fairly large suborbicular-triangular *Macoma* with slightly irregular concentric lamellae up to about 1 mm. apart and faint radial striae visible in oblique light.

Description—Interior cast and portion of right valve selected as neotype. Shell of moderately large size, suborbicular-triangular, probably fairly solid, subequilateral, gently inflated. Umbos probably small, antemedian. Anterior-dorsal margin nearly straight, gently sloping; posterior-dorsal margin longer, gently arcuate, more steeply sloping. Anterior margin roundly arcuate, posterior margin more narrowly arcuate. Ventral margin roundly convex.

Sculpture of sharp concentric lamellae widely spaced and generally about 6 in 4 mm., the interspaces crossed by numerous faint radial striae. Pallial sinus widely rhombic, apex at about the posterior one-third.

Dimensions (internal cast)—Height 32, length 36, inflation 15 mm.

Type Locality—Giles Point, near Edithburg.

Location of Neotype—Tate Museum Collection, University of Adelaide, F 15469.

Material—The neotype and 2 topotypes, Giles Point, 2 miles north of Coobowie; 4 specimens Moorlands, Section 6, Hundred of Sherlock.

Observations—The species appears to have features in common with *Tellina piratica* Hedley, 1918, collected by Basedow in the Buccaneer Archipelago. The pallial sinus is similar in shape to that of *piratica*.

Genus LACIOLINA Iredale, 1937

Type species (o.d.) *Tellina quoyi* Sowerby

Laciolina aldingae sp. nov.

pl. 2, fig. 4

Tellina lata Tate, 1887, p. 164, non Quoy and Gaimard.

Diagnosis—A large *Laciolina* with conspicuous concentric sculpture consisting of crowded striae on the outer layer, the inner layer and shell interior with broad concentric ribs about 2 mm. apart. Anterior margin rounded, posterior-ventral margin rostrate with fairly strong flexure.

Description—Shell large, subelliptical-subtriangular, only moderately inflated. Umbos small, submedian. Anterior of shell broken in holotype, posterior dorsal margin apparently straight, fairly steeply descending, posterior end produced, rostrate, strongly flexed, ventral margin convex.

Sculpture on surface layer on undecorticated portion of valve consisting of fine irregular crowded concentric striae about 4 per mm. Decorticated shell with broad rounded concentric ribs about 2 mm. apart on median part of shell. Pallial line only partly visible, pallial sinus not known.

Paratype an internal cast showing anterior margin; anterior-dorsal margin steeply sloping, anterior end narrowly rounded.

Dimensions—Holotype: Length (estimated) 125, height 75, inflation 28 mm.

Material—The holotype and two paratypes, 1 doubtful topotype.

Type Locality—Aldinga Bay, Pliocene.

Location of Types—Tate Museum Collection, University of Adelaide, holotype T 1210A, paratypes T 1210B, 1210C.

Observations—Tate (1887) referred the Aldinga specimens to the Recent "*Tellina lata* Quoy and Gaimard" on description and figures. A splendid series of the *Tellina lata* Q. and G. group has been generously made available on loan from the Australian Museum; *Laciolina quoyi* (Sowerby) (? = *Tellina lata* Q. and G.) C 15874 Hargraves Collection, from New Caledonia; *Laciolina chloroleuca* (Lamarck) C 15873 Hargraves Collection, New Caledonia; *Laciolina quoyi ? attracta* Iredale C 62322, Heron Island, Queensland; *Laciolina quoyi attracta* Iredale Paratype C 62323 Lord Howe Island; *Laciolina francesae* Iredale Paratype C 59874 Roy Bell Collection, Norfolk Island. From these it is clear that the Aldinga Pliocene species is distinct both in its dissimilar sculpture and in the strongly rostrate posterior margin. The state of preservation of the fossil renders the generic location a little doubtful. The low, rather narrow pallial sinus of *Laciolina* is not confirmed.

Family MACTRIDAE

Genus ANAPELLA Dall, 1895

Type species (o.d.) *Anapa triquetra* Hanley

Anapella variabilis (Tate)

pl. 4, figs. 5, 6

Anapa variabilis Tate, 1887, p. 172, pl. 17, figs. 5a-5b.

Anapella variabilis Tate, Ludbrook, 1955, p. 76 (synonymy).

Diagnosis—A small rather tumid subtrigonal *Anapella* with a rather narrow hinge.

Description—Holotype, left valve. Shell small for the genus, tumid, subtrigonal, inequilateral, thin but solid, umbo inflated, prosogyrous, anterior margin moderately narrowly arcuate, posterior dorsal margin longer than anterior dorsal margin. Anterior dorsal margin incurved near the umbo. Surface sculpture with fine growth ridges about 1 mm. apart near the umbo but increasing to about 4 per mm. towards the ventral border. Fine striae about 7 per mm. in the interspaces.

Hinge with a deep triangular resilifer. Dorsal margin deeply and narrowly notched under the umbo by the resilium. A grooved, oblique, narrowly triangular anterior cardinal bordering the resilifer with a small secondary denticle overhanging the resilifer at the top of the anterior cardinal. Both anterior and posterior laterals long and thin.

Anterior adductor moderately large, subovate, near the anterior-ventral margin, posterior adductor subovate at the posterior end of the hinge; pallial line simple.

Dimensions—Length 17·5, height 13·5, inflation (left valve) 6·5 mm.

Type Locality—Blanche Point, Aldinga Bay, Pliocene.

Location of Types—Tate Museum Collection, University of Adelaide, Holotype T 1209A, Paratypes T 1209.

Material—Holotype and 13 paratypes on Tate's original tablet; external moulds on limestone, identified from latex casts, Moorlands; specimens from Adelaide Plains Basin Government Bore No. 20, Woodville South, 362-380 feet associated with a larger species of *Anapella* (? *pinguis* Crosse and Fischer), and a megafauna distinct from that described by the writer from the Dry Creek Sands.

Class GASTROPODA

Family CERITHIIDAE

Subfamily CAMPANILINAE

Genus CAMPANILE Bayle, 1884

Type species (s.d. Crossman, 1906) *Cerithium giganteum* Lamarck

Campanile triseriale Basedow

pl. 5, figs. 2, 3, 4

Campanile triseriale Basedow, 1902, p. 130, pl. 2, fig. 1.

Diagnosis—A *Campanile* of normal size for the genus, sculptured with three rows of tubercles the adapical row axial, coarse, usually about 4 in 5 mm., separated by interspaces of the same size, median row narrow, set on a narrow cord ½ mm. wide, about 7 in 5 mm., adapertural row oblique, on a rib about 1 mm. wide, 6 tubercles per mm.

Description—Neotype. The neotype has been selected from the Howchin Collection in the South Australian Museum. It is a broken specimen tightly embedded in limestone with nine adult whorls only the posterior of which is visible externally. The original description and figure given by Basedow are consistent with the neotype, the estimated dimensions of which are height 130 mm., diameter 40 mm.

Hypotype. Mould in limestone, north side of Aldinga Bay, south of Blanche Point described from latex cast. Shell large, isostrophic, multispiral, turriculate. Early whorls (about 15) missing, 17 whorls remaining in a height of 90 mm. Whorls narrow, flat regularly sculptured with 3 rows of tubercles, the adapical row broad, one-third width of whorl, with broad tubercles 3 in 5 mm. in the last whorl, separated by approximately equal interspaces, median row of tubercles on a narrow, well-defined cord, about 1 mm. apart, adapertural row bordering the suture, with oblique tubercles about 4 in 5 mm. in the last three whorls.

Location of Types—Neotype, South Australian Museum, No. P 12660. Hypotype, South Australian Museum, No. P 12661.

Type Locality—Edithburg, Pliocene.

Observations—Seven good specimens of the original shells of this species are in the South Australian Museum with the locality label "Bore". The preservation leaves little doubt that the shells are from the Dry Creek Sands of the Adelaide Plains Basin. It is unfortunate that the locality has not been recorded as these are the only well preserved specimens showing the early part of the shell so far obtained; they are also the only record of the species from the Dry Creek Sands.

In the early whorls a narrow somewhat irregular cord occurs between the adapertural row of tubercles and the suture; this cord is gradually engulfed and disappears on later whorls. The aperture is obliquely rhomboid, siphonal canal strongly retroflexed.

Associated Species—Associated with the pelecypoda and one gastropod described above are several species the synonymy and descriptions of which have been published previously. These are included in the distribution table.

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EXPLANATION OF PLATES

PLATE 1

Fig. 1.—*Chlamys* (*Equichlamys*) *subbifrons* (Tate). Holotype, T 959A, x 2.
Fig. 2.—*Chlamys* (*Equichlamys*) *consobrina* (Tate). Holotype. T 937B, x 0·75.
Fig. 3.—*Chlamys* (*Equichlamys*) *palmipes* (Tate). Lectotype, T 932A, left valve, x 0·73.
Fig. 4.—*Chlamys* (*Equichlamys*) *palmipes* (Tate). Lectotype, T 932A, right valve, x 0·73.
Fig. 5.—*Chlamys* (*Equichlamys*) *palmipes* (Tate). Juvenile, Tailem Band, left valve, x 2. Mines Dept. Coll.
Fig. 6.—*Chlamys* (*Equichlamys*) *palmipes* (Tate). Juvenile, Tailem Bend, right valve, x 2. Mines Dept. Coll.

PLATE 2

Fig. 1.—*Spondylus spondyloides* (Tate). F 15470, x 1.
Fig. 2.—*Glans dennanti* (Tate and Basedow). Neotype, S.A. Mus. P 12657, x 2.
Fig. 3.—*Glans dennanti* (Tate and Basedow). Neotype, S.A. Mus. P 12657, x 2.
Fig. 4.—*Laciolina aldingae* Ludbrook, sp. nov. Holotype, T 1210A, x 1.

PLATE 3

Fig. 1.—*Anodontia sphericula* (Basedow) Hypotype, F 15471, left valve, x 1.
Fig. 2.—*Anodontia sphericula* (Basedow) Hypotype, F 15471, right valve, x 1.
Fig. 3.—*Anodontia sphericula* (Basedow) Hypotype, F 15471, exterior, x 1.
Fig. 4.—*Dosinia* (*Phacosoma*) *edithburgensis* Ludbrook sp. nov., Holotype, F 15467, x 0·85.
Fig. 5.—*Dosinia* (*Phacosoma*) *edithburgensis* Ludbrook sp. nov., Holotype, F 15467, x 0·85.

PLATE 4

Fig. 1.—*Ostrea arenicola* Tate. Tailem Bend. S.A. Mines Dept., F 196/58, left valve, x 0·75.
Fig. 2.—*Ostrea arenicola* Tate. Tailem Bend. S.A. Mines Dept., F 196/58, right valve, x 0·75.
Fig. 3.—*Macoma basedowi* (Tate). Neotype, F 15469, x 1·5.
Fig. 4.—*Macoma basedowi* (Tate). Neotype, F 15469, x 1·5.
Fig. 5.—*Anapella variabilis* (Tate). Holotype, T 1209A, x 3·7.
Fig. 6.—*Anapella variabilis* (Tate). Holotype, T 1209A, x 3·7.

PLATE 5

Fig. 1.—*Anodontia sphericula* (Basedow). Neotype, Edithburg. S.A. Mus., P 12658, x 1.
Fig. 2.—*Campanile triseriale* Basedow. Latex cast of hypotype, P 12661, x 1.
Fig. 3.—*Campanile triseriale* Basedow. Neotype, Edithburg. S.A. Mus., P 12660, x 1.
Fig. 4.—Cast of *Anodontia sphericula* and mould of *Campanile triseriale* hypotype, in limestone, Aldinga Bay. S.A. Mus., P 12661, x 1.

(*All photographs by courtesy of S.A. Museum.*)